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Status of Forest Fertilization Program
N. B. Department of Forests, Mines and Energy

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DEPARTMENT OF FORESTS, MINES AND ENERGY
TIMBER MANAGEMENT BRANCH
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INTRODUCTION

Forest fertilization in New Brunswick, as well as the rest of eastern Canada is still very much in an experimental stage. Due to the fact that there are substantial differences in the types and levels of nutrient requirements for different stands, the feasibility of large scale forest fertilization programs cannot be established without a large number of localized trials.

The Department of Forest, Mines and Energy has established 29 of these trials since 1971 (Appendix I). The first 7 trials were established in semi or near mature unmanaged jack pine and hardwood stands. The 22 trials established since 1976 have been concentrated in plantations or young spaced stands. No new trials have been established since 1983.

Experimental trials were established to test the effects of various fertilizers and application rates on basal area and volume increments, while those trials established in young plantations test fertilizer effects on height increments. Measurements of dbh or height were originally scheduled to be taken annually for 10 years. This procedure was abandoned in 1982 due to the manpower and time required to remeasure the number of trials which had been established. Current procedure calls for the measurements to be taken annually for the first five years, then a final measurement at ten years. However, the final results for the hardwood trials will be for a 5-year period, instead of ten. This is a result of the high mortality at the Dunbar Stream trial and the unplanned harvesting of the Stairs Hill trial. In addition, final results for the jack pine trial at Tracadie South will be for a 5-year period due to an unplanned thinning of the trial. Results for the plantation trials are not available at this time but will be forthcoming.

Each year this report will be updated, adding the results of 5-year or 10-year measurements.

METHODS

Nitrogen (N), phosphorus (P), and potassium (K) fertilizers were applied in various amounts and combinations to determine basal area, volume and height growth response. Nitrogen was applied as urea (45%N) denoted as URN in this report, ammonium nitrate (34%N) denoted as AN, or ammonium sulphate (20%N) denoted AS, phosphorus as triple superphosphate (46%P_2O_5), and potassium as murate of potash (50%K_2O). In this report, the amounts of fertilizer applied are equivalent to kilograms of element per hectare and are indicated in Kg/ha immediately following the letter designation for the fertilizer treatment.

The treatment codes for the 1976 and 1977 jack pine trials (Table 4) consist of an amount of fertilizer in Kg/ha followed by a thinning code. Two levels of thinning, intermediate, denoted as I, at approximately 1.8 m x 1.8 m spacing and heavy, denoted as H, at approximately 2.4 m x 2.4 m spacing were applied. In addition, some fertilizer treatments were applied 2, 3 and 4 years after thinning. These treatments are denoted by a number in brackets after the thinning code.

Throughout the trials, the treatments were used in a replicated, randomized complete block design. The number of replicates depended on the area of the stand and the number of treatments to be applied. Circular plots, to which the individual treatments were applied, were established throughout the stands, with their centres at least 46 m from one another. The individual plots were established as concentric double-circles, 0.02 and 0.04 hectares in size. Although the entire 0.04 ha plot was fertilized and/or thinned, only trees within the 0.02 ha were measured and then numbered with spray paint. Prior to fertilization, the diameters of all living trees were measured by diameter tape to the nearest 0.025 cm (0.01 inch). A horizontal line was painted on each tree bole at breast height to ensure consistency in subsequent measurements. Tree diameters were remeasured every fall for a period of five to ten years, and were used to determine periodic basal area growth response.

A height-diameter relationship was determined for each stand at fertilization, by measuring the dbh and the total height of two codominant trees per plot. Total tree volumes were determined by substituting both measured dbh, and the height calculated from the height-diameter relationship into Honer's (1967) standard volume equations. Merchantable tree volumes were calculated by multiplying Honer's (1967) merchantable conversion factors by the total tree volumes. A stump height of 15 cm (0.5 feet) and a minimum top diameter of 7.6 cm (3.0 inches) for softwoods,

and 10.1 cm (4.0 inches) for hardwoods was assumed.

The individual tree basal areas and volumes were summed to give plot and treatment totals. The difference between the appropriate initial and final plot totals, gave the periodic response in either basal area or total volume. The periodic basal area increment (PBAI) and the periodic volume increment (PVI) plot values were calculated by using a Fortran program written by B. M. Smith and processed on the UNIVAC computer.

The volume lost to mortality was determined for each treatment, and these results are presented in Figures 1 through 11. The average stand mortality, over all treatments, controls included, was calculated for each location and presented in Table 5.

Covariance analysis, using initial total volume as the independent covariate, was used to determine if there were any statistical differences among the treatments (Appendix VIII). In addition, a multiple-range test was performed to identify which treatment means, if any, were significantly different from each other. The test used was the Student-Newman-Keuls Test (Steel and Torrie, 1960). Treatment effects are marked significant if they meet the test criterion at the 5% level of probability. In all cases, statistical analyses were performed on the plot means, using the SPSS-X (1983) statistical program, which was available on the UNIVAC computer.

RESULTS

Treatment effects are evaluated from net periodic increment (PI) in total stand volume. Net PI is defined as gross PI minus mortality. Corresponding increments in basal area (BA) and merchantable volume (MV) are given together with the initial stand measurements in Appendix III - VII. Stand descriptions at the time of fertilization are given in Appendix II.

Dunbar Stream

The 80-year-old sugar maple stand at this location has been subject to high mortality, averaging 5.11 m^3/ha/yr (Table 5), throughout the trial. This is the result of an insect infestation.

The 5-year remeasurement data show a best response over control with AN112 at 24.9 m^3/ha (Table 1) or a relative increase of the PI by 24%. However, all other treatments showed either minor increases above control, or losses as much as 20.5 m^3/ha below the control. As a result, the differences between growth on control and treated plots were statistically not significant.

Crow Hill

The 5-year remeasurement data for this 35-year-old hardwood stand show a minimal response to N, regardless of the application rate or fertilizer type. The best response was 8% over control with URN112 at 2.2 m^3/ha (Table 2). The differences between growth on control and treated plots were statistically not significant.

Stairs Hill

The response to N fertilization in this 35-year-old hardwood stand was also statistically not significant (Table 2). The best response was 20% over control, with AN112 at 4.5 m^3/ha. The poorest response was shown by URN112 at 16% or 3.7 m^3/ha below control.

Magaguadavic

This predominantly white birch stand was partially fertilized in the spring and fall of the same year, to determine possible differences due to the season of fertilizer application. All treatments applied in the fall indicated a greater volume response than those applied in the

spring (Table 2). However, these differences were not significant.

The application of N resulted in significantly improved growth for the 5-year period. For the spring application, gains in TV of 4.1 - 10.6 m^3/ha (Table 2) and a relative increase of the PI by 38 - 100% were realized. For the fall application, gains in TV of 5.5 - 13.5 m^3/ha (Table 2) and a relative increase of the PI by 40 - 100% were realized. The best response to both a spring and fall application was AN448 at 100% above control. The successful treatments, those that showed significant differences above control, did not differ significantly among themselves (Table 2).

Rogersville

The 10-year PI of this 29-year-old jack pine stand was 53.0 m^3/ha when no fertilizers were applied (Table 3). The PI was significantly increased above control with four of the treatments, ranging from the lowest rate URN168 to the higher rate URN336. These gains varied from 16.5 - 23.8 m^3/ha, corresponding to a relative increase of the PI by 31 - 45%.

Tracadie Range

The 10-year PI of this 35-year-old jack pine stand was 49.8 m^3/ha at indigenous nutrient supplies (Table 3). All the treatments showed periodic volume increases above the control. However, only one treatment, URN336 P112, showed a statistically significant increase over control at 21.8 m^3/ha or a relative increase of 44%.

County Line

The 10-year PI on control plots amounted to 46.2 m^3/ha, for this 40-year-old jack pine stand (Table 3). Only one treatment, URN224 P112, showed a statistically significant increase over control at 12.3 m^3/ha or a relative increase of 27%.

Salmon Brook

The 5-year PI on control plots amounted to 33.9 m^3/ha, for this 31-year-old jack pine stand (Table 4). Six of the twelve treatments applied showed statistically significant increases over control. These increases ranged from 8.7 m^3/ha with 200-H, to 13.6 m^3/ha with 300-I, corresponding to a relative increase of the PI by 26-40%.

Grand Lake Road

The 6-year PI on control plots amounted to 36.8 m^3/ha, for this 30-year-old jack pine stand (Table 4). Five-year remeasurement results were not available. Four of the twelve treatments applied showed statistically significant increases over control. These increases ranged from 10.6 m^3/ha with 100-I, to 15.9 m^3/ha with 300-I, corresponding to a relative increase of the PI by 29-43%.

Tracadie North

The 5-year PI on control plots amounted to 30.0 m^3/ha, for this 40-year-old jack pine stand (Table 4). Eight of the thirteen treatments applied showed statistically significant increases over control. These increases ranged from 4.4 m^3/ha with 200-H(2), to 10.2 m^3/ha with 200-I corresponding to a relative increase of the PI by 15-34%.

Tracadie South

The 5-year PI on control plots amounted to 25.0 m^3/ha, for this 40-year-old jack pine stand (Table 4). Nine of the thirteen treatments applied showed statistically significant increases over control. These increases ranged from 8.5 m^3/ha with 100-0, to 21.7 m^3/ha with 200-I, corresponding to a relative increase of the PI by 34-87%.

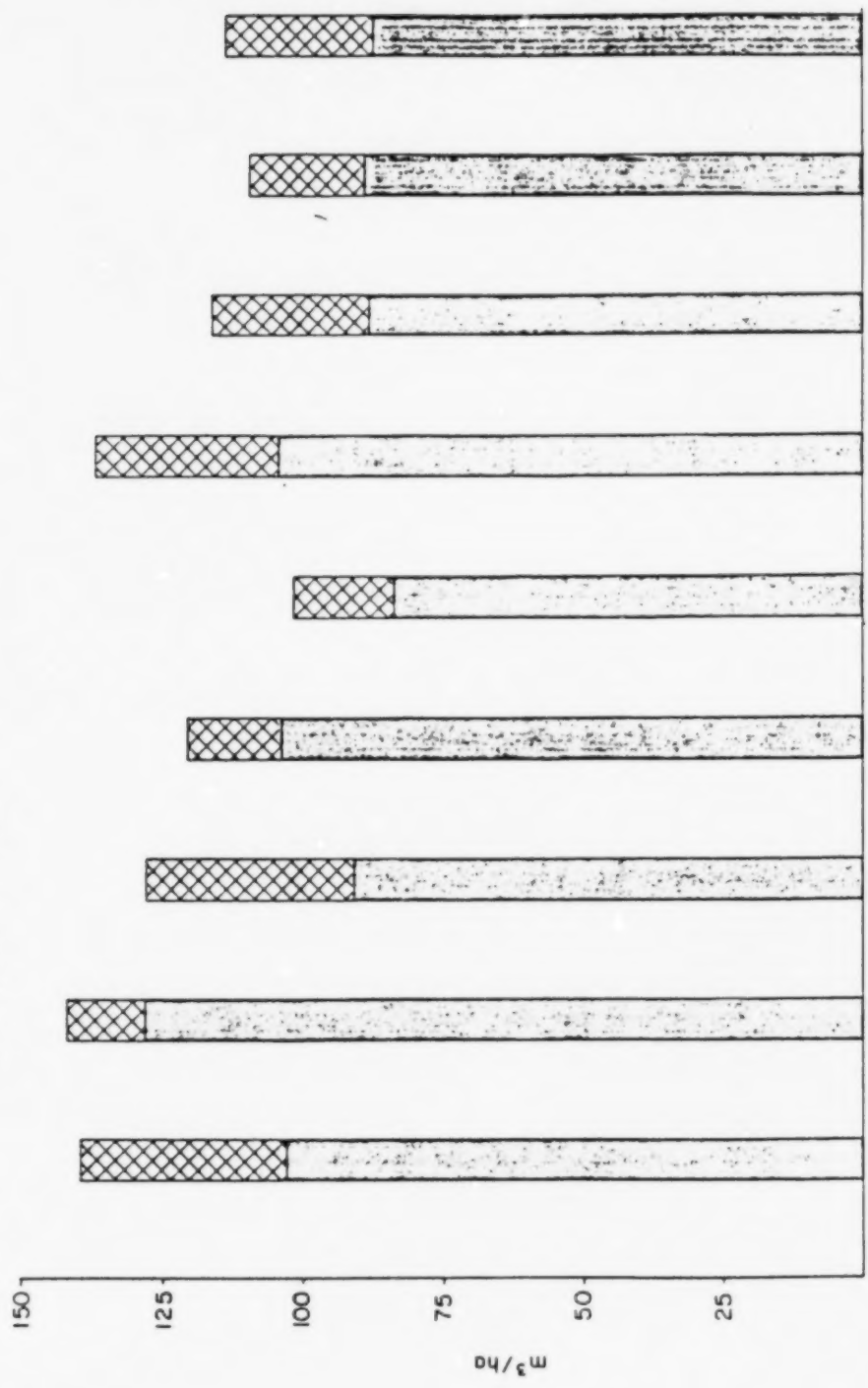

FIGURE 1 - Gross and net volume increments 5 years following fertilizer application at the Dunbar Stream.

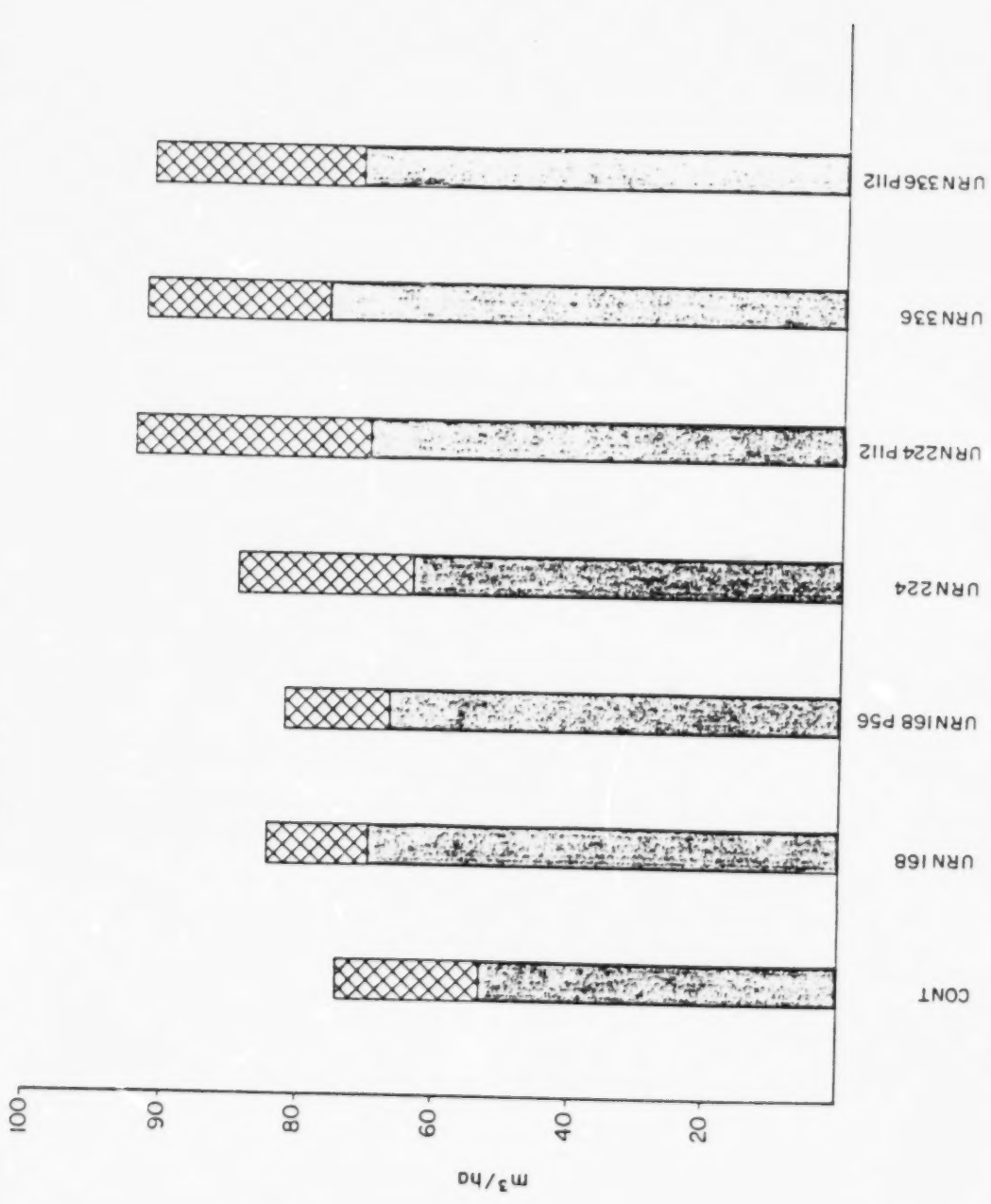

FIGURE 2 - Gross and net volume increments 10 years following fertilizer application at Rogersville.

FIGURE 3 - Gross and net volume increments 10 years following fertilizer application at Tracadie Range.

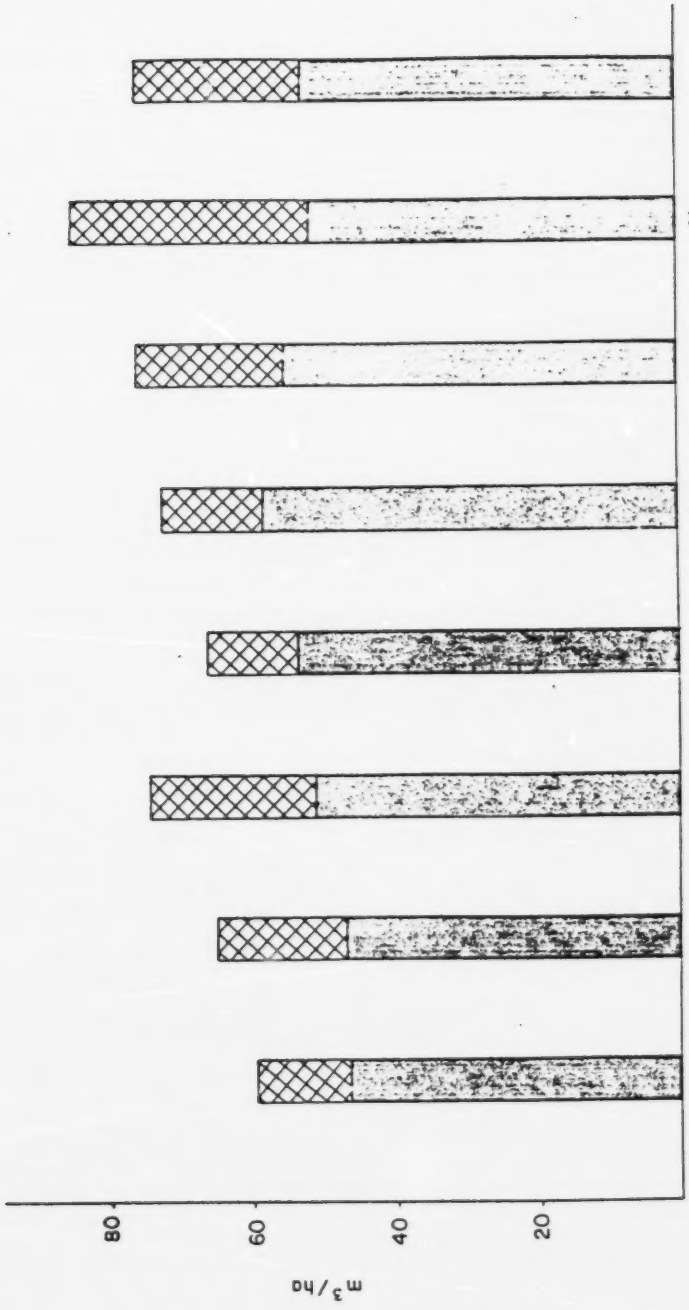

FIGURE 4 - Gross and net volume increments 10 years following fertilizer application at County Line.

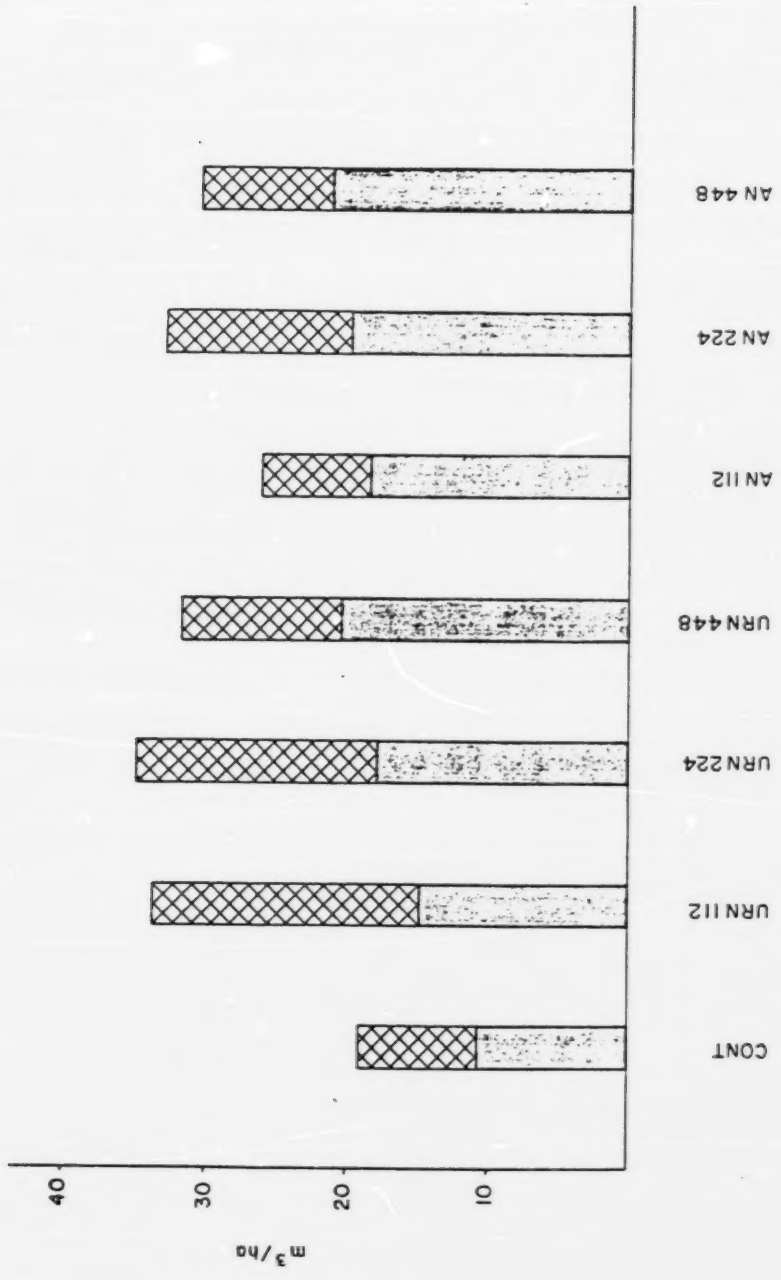

FIGURE 5a - Gross and net volume increments 5 years following fertilizer application at Little Magaguadavic Lake. (spring)

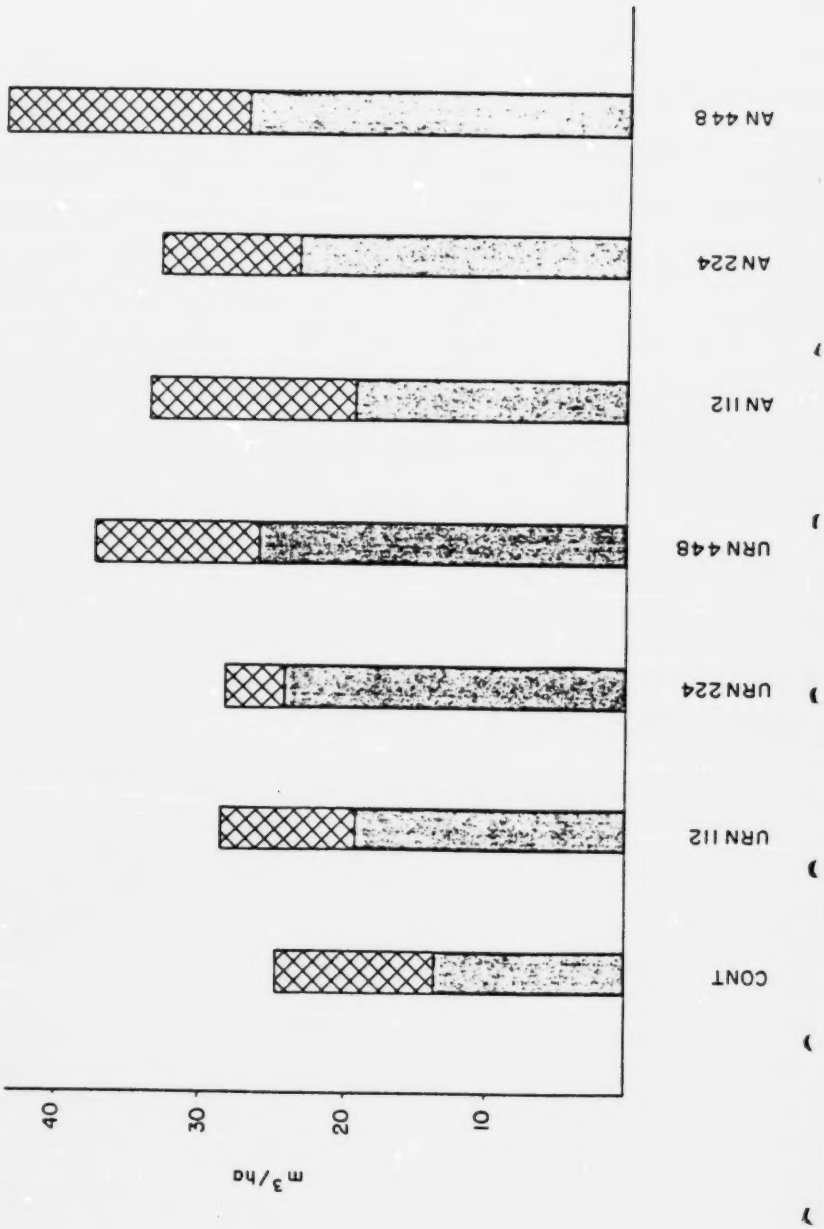

FIGURE 5b - Gross and net volume increments 5 years following fertilizer application at Little Magaguadavic Lake.(fall)

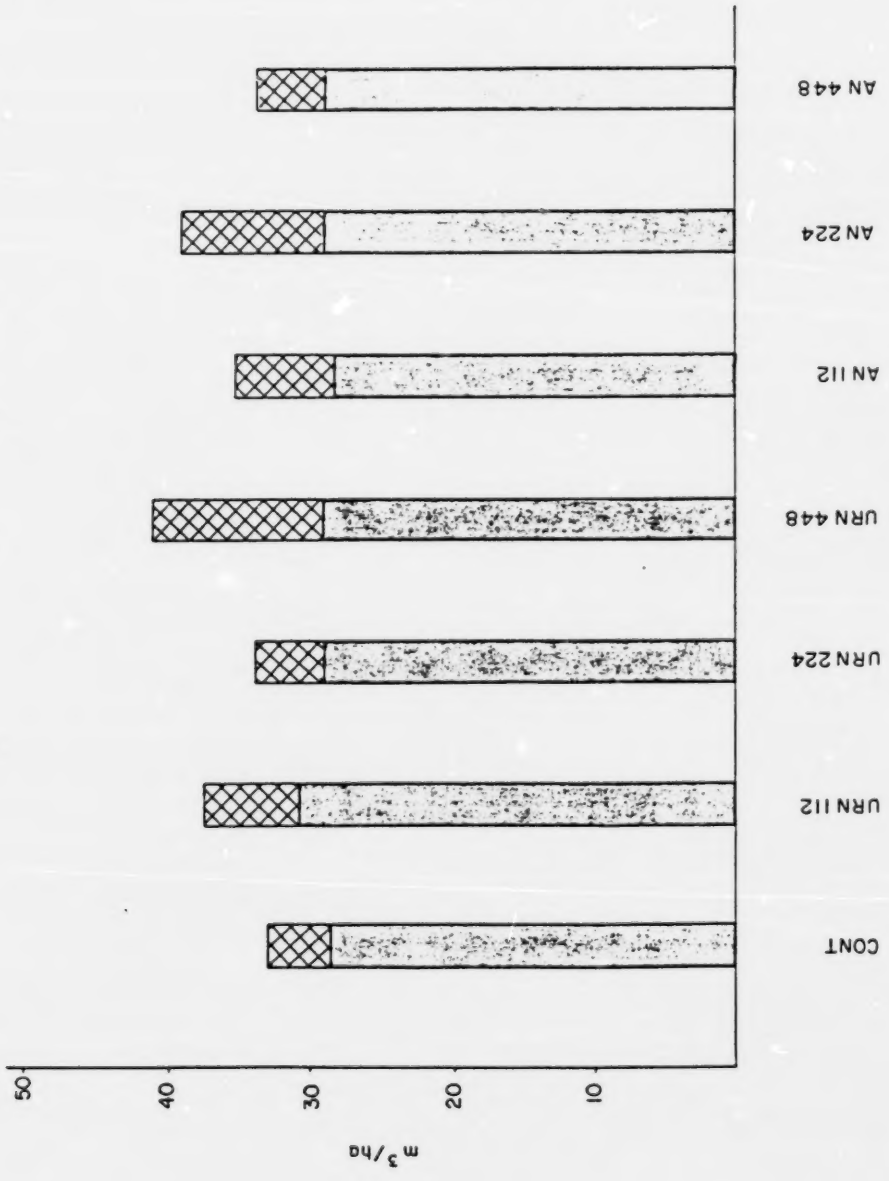

FIGURE 6 - Gross and net volume increments 5 years following fertilizer application at Crow Hill.

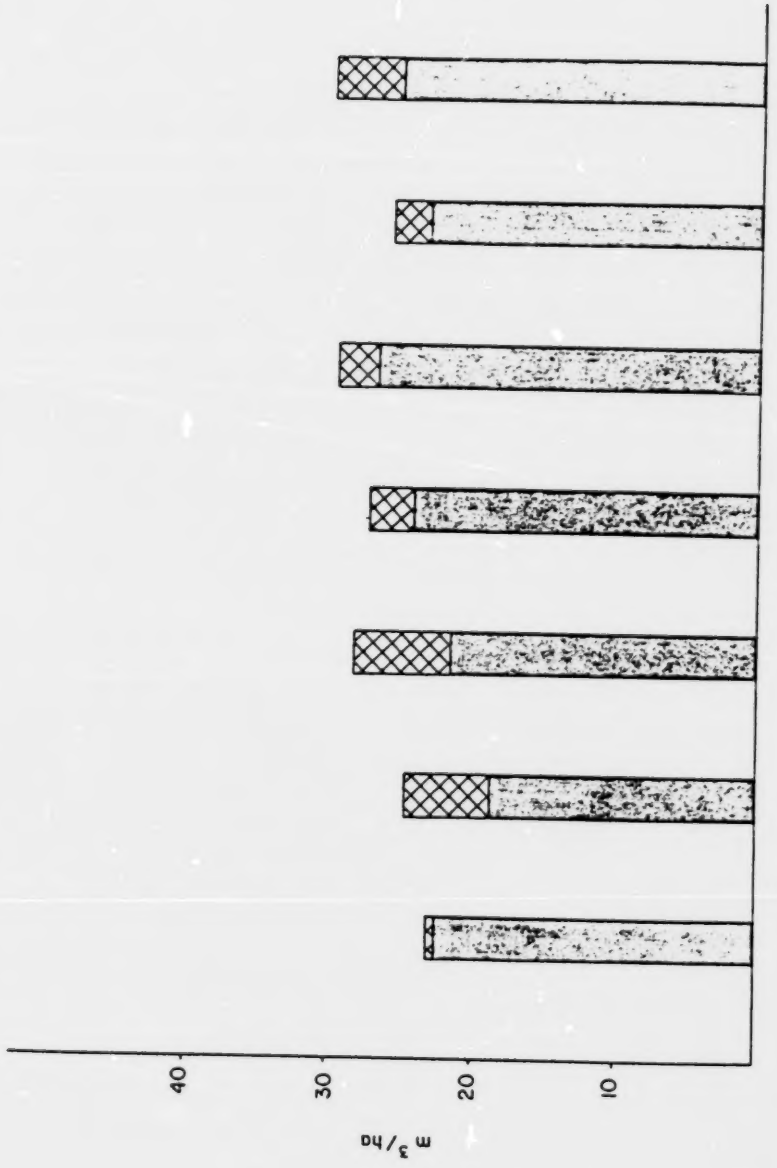

FIGURE 7 - Gross and net volume increments 6 years following fertilizer application at Stairs Hill.

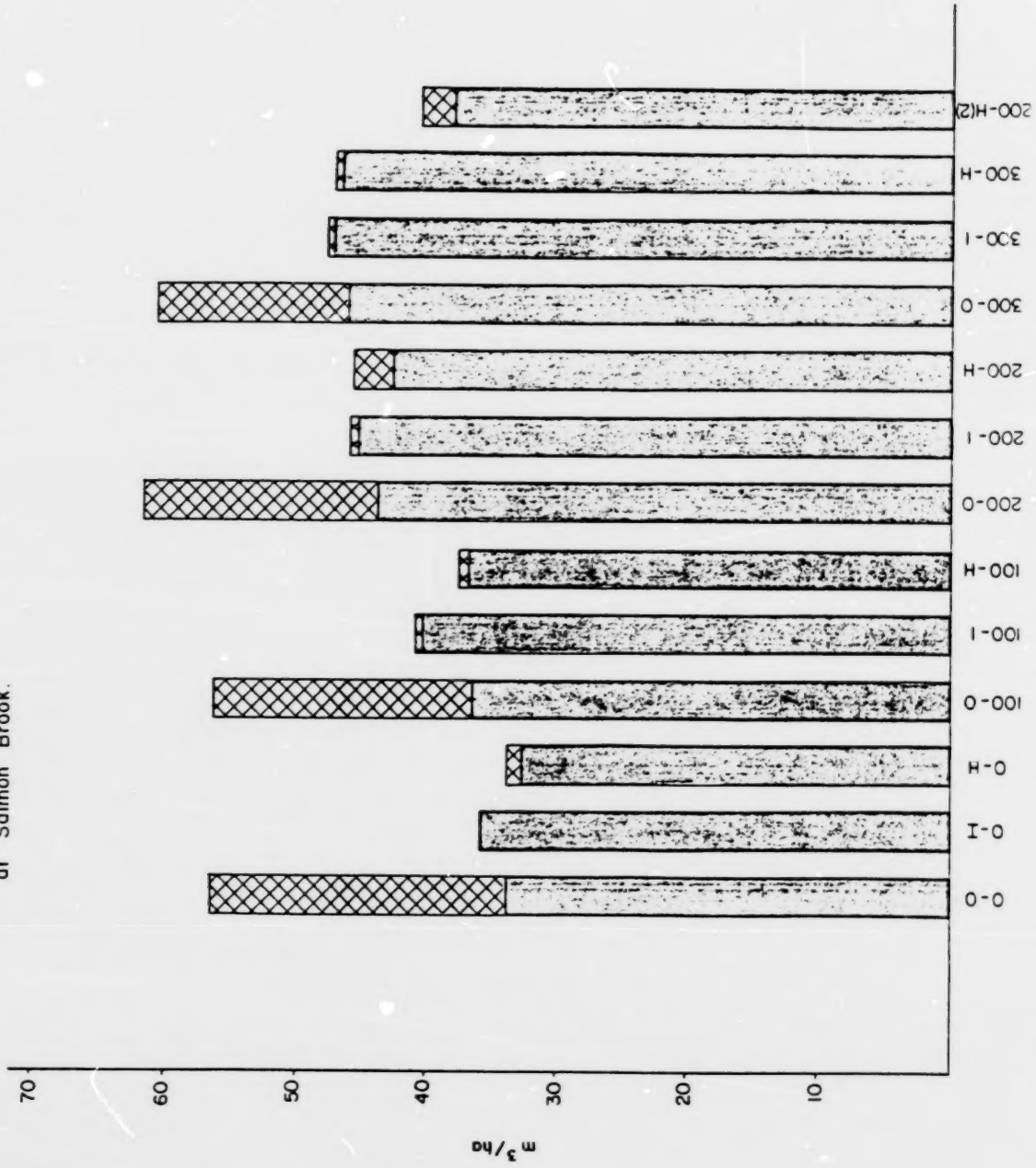

FIGURE 8 - Gross and net volume increments 5 years following fertilizer application at Salmon Brook.

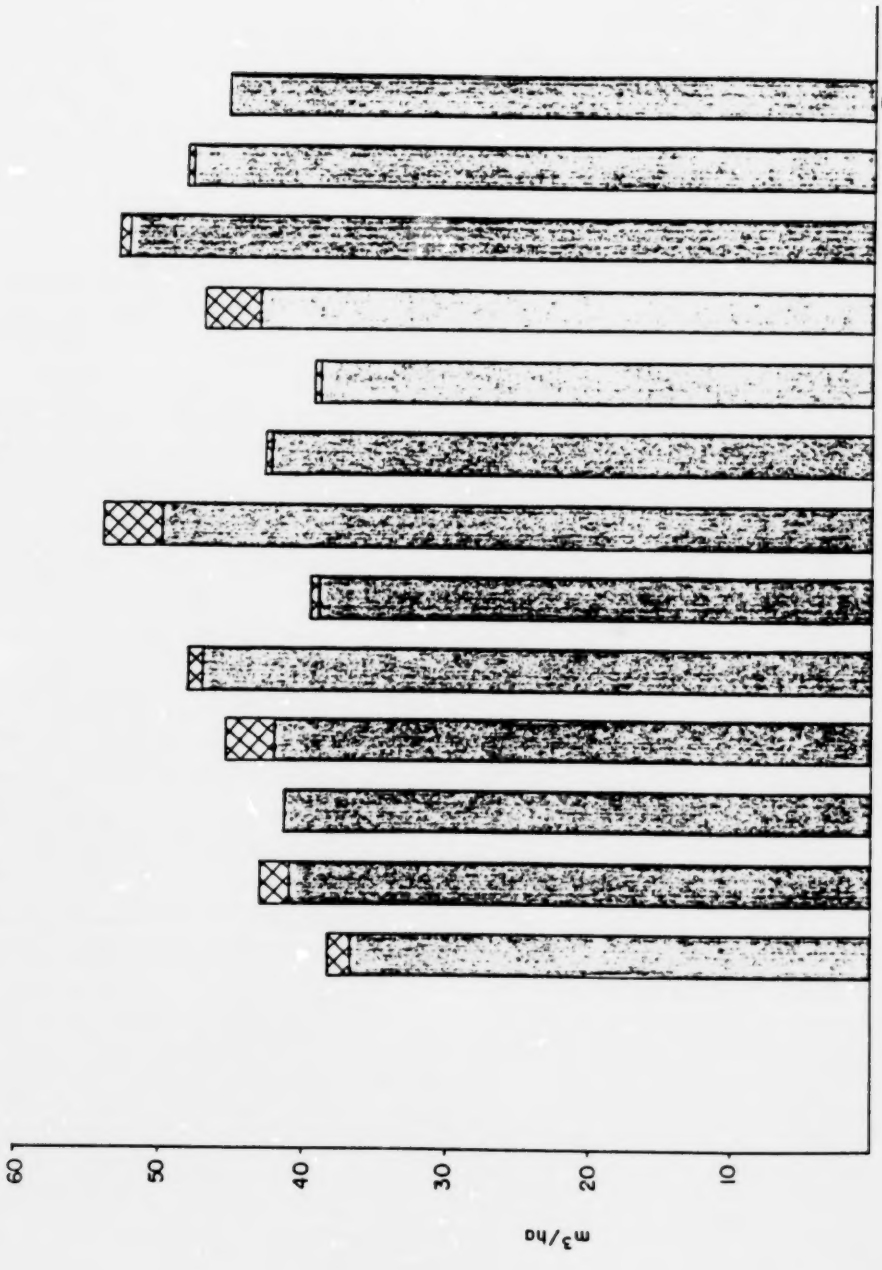

FIGURE 9 - Gross and net volume increments 6 years following fertilizer application at the Grand Lake Road.

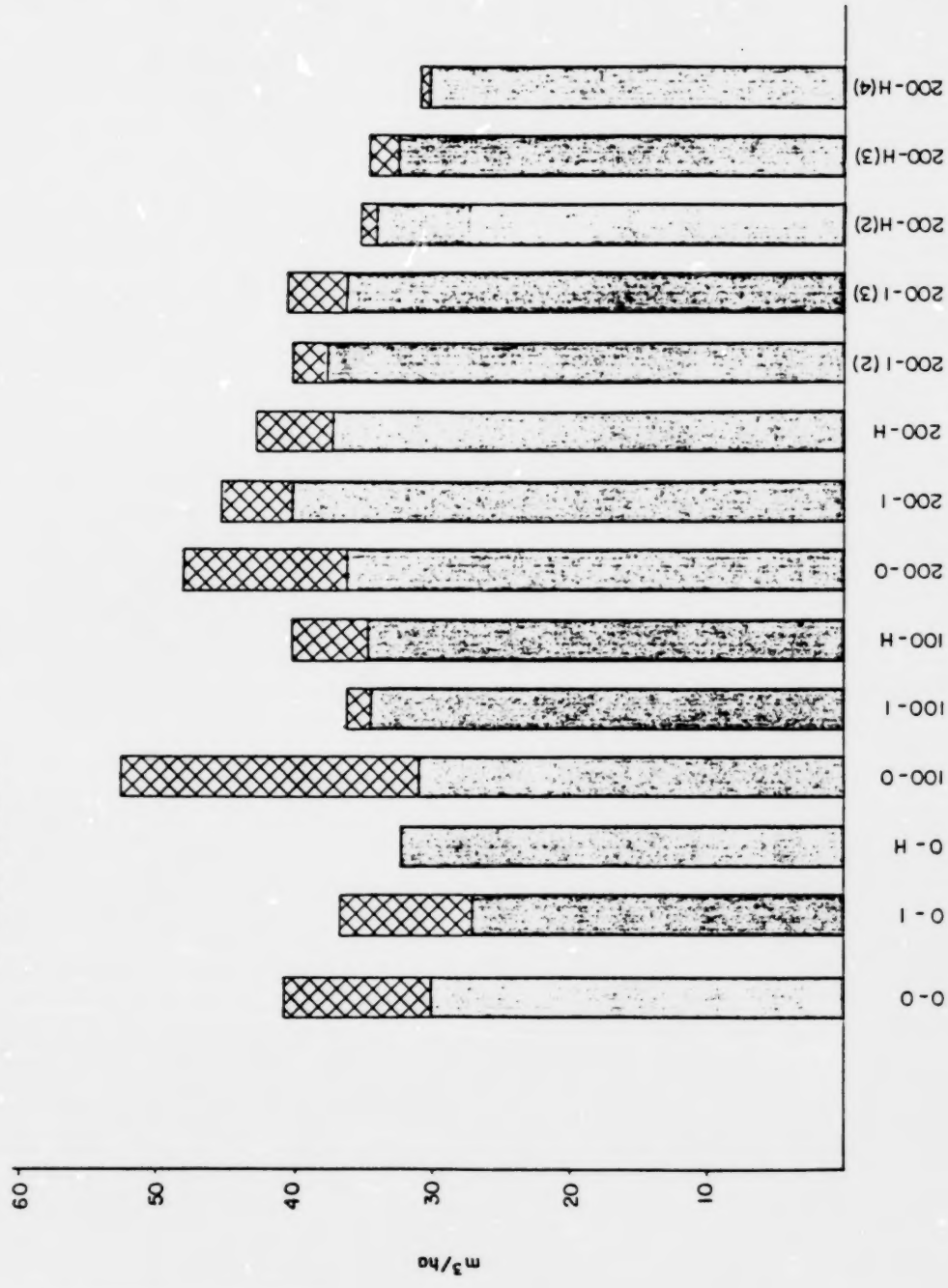

FIGURE 10 - Gross and net volume increments 5 years following fertilizer application at Tracadie North.

FIGURE II - Gross and net volume increments 5 years following fertilizer application at Tracadie South.

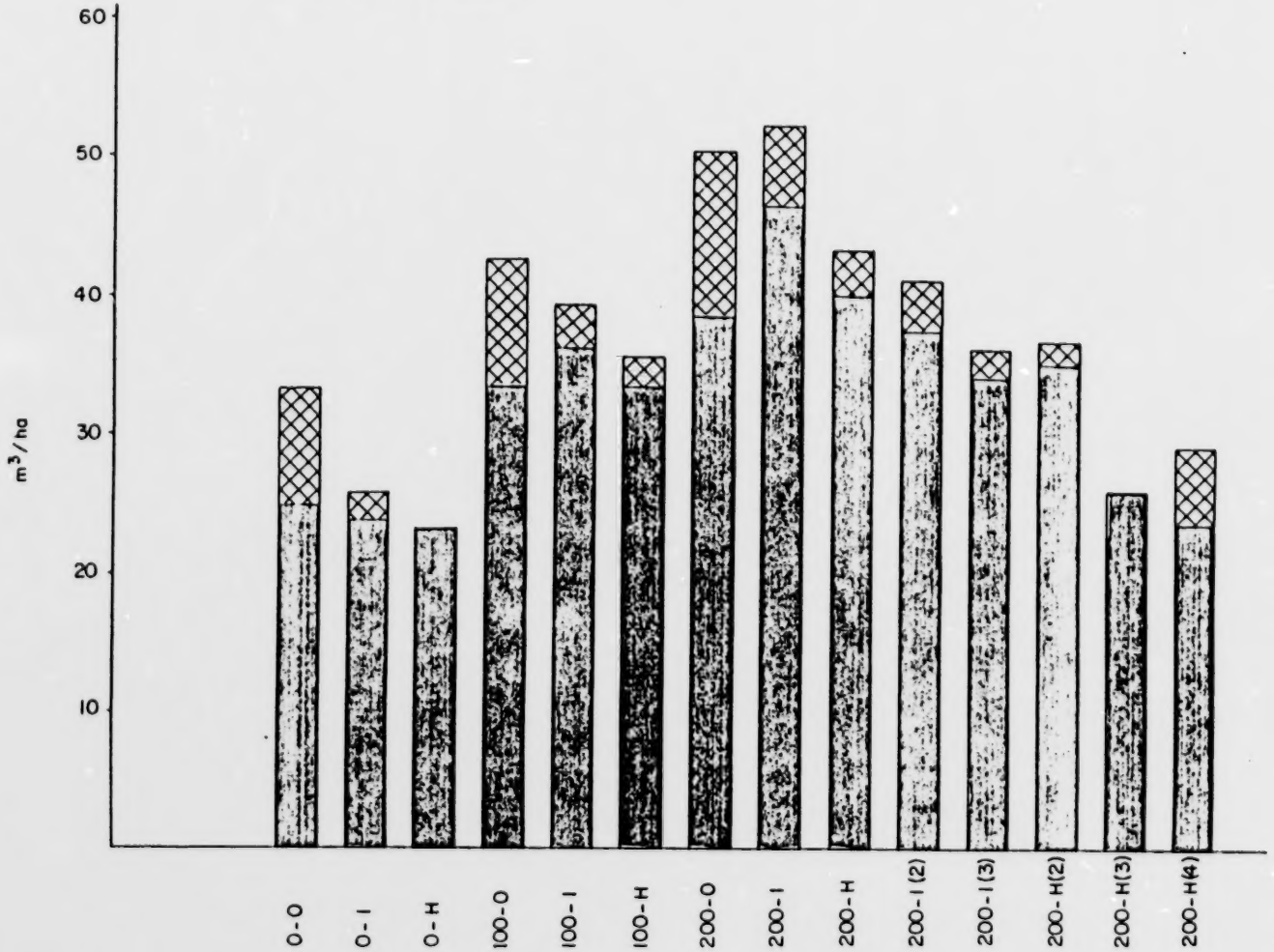

Table 1. Initial total volume (IV) and periodic increments (PI) in an untreated and fertilized sugar maple stand in New Brunswick.

Location	PI (years)	Initial IV	Incremental Response (m^3/ha)								
			CONT	AN112	AN168 P112	AN168 K112	P112 K112	AN168 P112 K112	K112	P112	URN168
Dunbar Stream #	5	321	103.5[a]	128.4[a]	91.8[a]	104.9[a]	83.0[a]	105.2[a]	89.4[a]	90.0[a]	88.3[a]

Treatments marked by the same letter do not differ significantly from each other at P = 0.05.

Table 2. Initial total volume (TV) and periodic increments (PI) in untreated and fertilized hardwood stands in New Brunswick.

Location	PI (years)	Initial TV	Incremental Response (m^3/ha)						
			CONT	URN112	AN112	URN224	AN224	URN448	AN448
Crow Hill #	5	131	28.5^a	30.7^a	28.2^a	29.0^a	29.0^a	29.2^a	28.7^a
Stairs Hill	6	99	22.4^a	18.7^a	26.9^a	21.4^a	23.3^a	24.2^a	25.4^a
Magaguadavic(S)+	5	157	10.6^a	14.7^{ab}	18.3^b	17.7^b	19.7^b	20.3^b	21.2^b
Magaguadavic(F)	5	157	13.5^a	19.0^{ab}	19.2^{ab}	24.0^b	23.2^b	25.9^b	26.9^b

Treatments marked by the same letter do not differ significantly from each other at P = 0.05.

+ Indicates fertilizer applied in the spring (S) and in the fall (F).

Table 3. Initial total volume (IV) and periodic increments (PI) in untreated and fertilized jack pine stands in New Brunswick.

Location	PI (years)	Initial IV	Incremental Response (m^3/ha)							
			CONT	URN168	URN168 P56	URN224	URN224 P112	URN336	URN336 P112	AN224
Rogersville #	10	153	53.0^{a}	69.5^{b}	66.8^{ab}	63.6^{ab}	70.2^{b}	76.8^{b}	72.2^{b}	-
Tracadie Range	10	159	49.8^{a}	53.3^{a}	56.9^{ab}	57.2^{ab}	60.2^{ab}	63.6^{ab}	71.6^{b}	62.7^{ab}
County Line	10	149	46.2^{a}	47.4^{a}	51.2^{ab}	53.4^{ab}	58.5^{b}	55.7^{ab}	58.0^{ab}	53.3^{ab}

Treatments marked by the same letter do not differ significantly from each other at P = 0.05.

Table 4. Initial total volume (TV) and periodic increments (PI) in untreated and thinned/fertilized jack pine stands in New Brunswick.

Location	PI (years)	Initial TV	Incremental Response (m^3/ha)																
			0-0	0-I	0-H	100-0	100-I	100-H	200-0	200-I	200-H	300-0	300-I	300-H	200-I (2)+	200-I (3)	200-H (2)	200-H (3)	200-H (4)
Salmon Brook #	5	132	33.9^{a}	35.6^{ab}	33.7^{a}	36.5^{ab}	40.3^{abcd}	36.9^{ab}	43.9^{bcd}	45.4^{cd}	42.6^{bcd}	46.2^{d}	47.5^{d}	46.9^{d}	-	-	38.0^{abc}	-	-
Grand Lake Road	6	86	36.8^{a}	41.2^{abc}	41.6^{abc}	42.2^{abc}	47.4^{bcd}	39.4^{ab}	50.1^{cd}	42.8^{abc}	49.2^{bcd}	43.6^{abcd}	52.7^{d}	48.3^{bcd}	-	-	45.9^{abcd}	-	-
Tracadie North	5	170	30.0^{ab}	27.1^{a}	32.2^{abc}	31.0^{abc}	34.6^{bcd}	34.7^{bcd}	36.2^{bcd}	40.2^{d}	37.4^{bcd}	-	-	-	37.8^{cd}	36.5^{bcd}	34.4^{bcd}	32.7^{abc}	30.5^{abc}
Tracadie South	5	136	25.0^{a}	23.8^{a}	23.4^{a}	33.5^{b}	36.3^{b}	33.6^{b}	38.8^{b}	46.7^{c}	40.3^{b}	-	-	-	37.7^{b}	34.4^{b}	35.4^{b}	26.1^{a}	24.0^{a}

Treatments marked by the same letter do not differ significantly from each other at P = 0.05.
+ Fertilizer treatments applied 2, 3 and 4 years after thinning.

Table 5. Tree mortality for the fertilization trials.

Location	PI (years)	Range (m^3/ha)	Average (m^3/ha)	Annual (m^3/ha/yr)
Dunbar Stream	5	14.14 (AN112) - 36.50 (CONT)	25.57	5.11
Crow Hill	5	4.31 (CONT) - 11.92 (URN400)	7.03	1.40
Stairs Hill	6	0.41 (CONT) - 6.80 (URN200)	3.73	0.62
Magaguadavic(S)	5	7.60 (AN100) - 18.88 (URN100)	13.74	2.74
Magaguadavic(F)	5	4.12 (URN200) - 17.13 (AN400)	11.00	2.20
Rogersville	10	15.44 (URN168) - 25.97 (URN224)	20.25	2.02
Tracadie Range	10	2.92 (AN224) - 11.23 (URN168)	6.47	0.65
County Line	10	12.73 (URN224) - 33.66 (URN336P112)	19.69	1.97
Salmon Brook	5	0.0 (0-I) - 22.60 (0-0)	6.42	1.28
Grand Lake Road	6	0.0 (0-H) - 4.04 (200-0)	1.31	0.22
Tracadie North	5	0.0 (0-H) - 21.64 (100-0)	5.86	1.17
Tracadie South	5	0.0 (0-H) - 11.85 (200-0)	4.20	0.84

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APPENDICES

Appendix I. Forest Fertilization Trials established by Timber Management Branch.

YEAR	LOCATION	SPECIES	GROWTH RESPONSE	FERTILIZER TREATMENTS AND RATES*
1971	Dunbar Stream	sM (natural)	BA, VOL	Urea N(168), [1]AN(112, 168), P(112), K(112) kg/ha
1973	Rogersville	jP (natural)	BA, VOL	Urea N(168, 224, 336), P(56, 112) kg/ha
1974	Tracadie Range	jP (natural)	BA, VOL	Urea N(168, 224, 336), P(56, 112), AN (224) kg/ha
	County Line	jP (natural)	BA, VOL	Urea N(168, 224, 336), P(56, 112), AN (224) kg/ha
1975	Magaguadavic	wB, rM (natural)	BA, VOL	Urea N(112, 224, 448), AN (112, 224, 448) kg/ha
	Crow Hill	sM, Be (natural)	BA, VOL	Urea N(112, 224, 448), AN (112, 224, 448) kg/ha
	Stairs Hill	sM, Be (natural)	BA, VOL	Urea N(112, 224, 448), AN (112, 224, 448) kg/ha
	Despres Lake	rP (plantation)	HT	30-10-10 (112, 224), Urea N(112, 224), AN (112, 224) kg/ha
1976	Salmon Brook	jP (thinning)	BA, VOL	[2]Urea N (100, 200, 300) kg/ha, Thinned (6'X 6', 8'X 8')
	Grand Lake Road	jP (thinning)	BA, VOL	[2]Urea N (100, 200, 300) kg/ha, Thinned (6'X 6', 8'X 8')
1977	Tracadie North	jP (thinning)	BA, VOL	[3]Urea N (100, 200) kg/ha, Thinned (7'X 7', 9'X 9')
	Tracadie South	jP (thinning)	BA, VOL	[3]AN (100, 200) kg/ha, Thinned (7'X 7', 9'X 9')
1978	East Collette	rP (thinning)	BA, VOL	Urea N (100, 200), AN (100, 200), [4]AS (100, 200) kg/ha
	Butler	rP (plantation)	BA, VOL, HT	Urea N (75, 150), AN (75, 150) kg/ha
	Newcastle Corner	rP (plantation)	HT	Urea N (75, 150), AN (75, 150) kg/ha
1979	Mines Road	jP (thinning)	BA, VOL	AN (128), P(19), K(71) kg/ha
	Dungarvan River	jP (plantation)	BA, VOL, HT	AN (150), P(50), K(100) kg/ha
	Blissville	rP (thinning)	BA, VOL	AN (200, 400), K(100) kg/ha
1980	Tracadie Range	jP (plantation)	HT	AN (150), P(50), K(100) kg/ha
	McKean Brook	jP (plantation)	HT	AN (150), P(50), K(100) kg/ha
	Green River	bS, bF (spaced)	BA, VOL	Urea N(150), P(50), K(100) kg/ha
	Otter Brook	bS, bF (spaced)	BA, VOL	AN (150), P(50), K(100) kg/ha
1981	Homers Road	wS (plantation)	HT	Urea N(150), AN (150), P(50), K(50) kg/ha
	Dennis Beach	wS (plantation)	HT	Urea N(150), AN (150), P(50), K(50) kg/ha
	(Aerial) Trout Brook	jP (plantation)	HT	Urea N(150), AN (150) kg/ha
1982	Nashwaak Lake	bF (spaced)	BA, VOL	Urea N(75, 150), P(50), K(50) kg/ha
	Chocolate Brook	bS (plantation)	HT	Urea N(75, 150), P(50), K(50) kg/ha
	(Aerial) Tabu Airstrip	jP (plantation)	HT	Urea N(113) kg/ha
1983	(Aerial) Otter Brook	bS (plantation)	HT	Urea N(70) kg/ha

* Application rates are equivalent to kilograms of element per hectare.

1 Ammonium Nitrate

2 Urea N(200) applied on some plots two years after thinning.

3 Some fertilizer treatments were applied 2, 3 and 4 years after thinning.

4 Ammonium Sulphate

Appendix II. Stand descriptions at the time of fertilization.

Location	Stand Type	Age	Origin	Ground Vegetation	Site Description
Dunbar Stream	Sugar Maple Yellow Birch	80	cut	hobblebush	moist, well-drained, hilly northeasterly aspect
Rogersville	Jack Pine	29	fire	rhododendron sheep laurel bracken fern	podzolic sandy soil, poorly drained, flat
Tracadie Range	Jack Pine	35	fire	rhododendron sheep laurel bracken fern	podzolic loamy sand, moderate drainage, flat
County Line	Jack Pine	40	fire	rhododendron sheep laurel bracken fern	podzolic sandy clay, moderate to good drainage, flat to rolling with a gentle southerly aspect
Magaguadavic	White Birch Red Maple	40	fire	club moss sarsaparilla striped maple bunch berry	podzolic loam, well drained, rolling westerly aspect
Crow Hill	Maple Beech	35	cut	hobblebush	podzolic clay loam, good drainage, hilly southwesterly aspect
Stairs Hill	Maple Beech	35	cut	hobblebush	podzolic clay loam, good drainage, hilly easterly aspect
Salmon Brook	Jack Pine	31	fire	rhododendron bracken fern	podzolic sandy loam, humus 1 to 2", rooting depth 14", rolling

Appendix II. (continued)

Location	Stand Type	Age	Origin	Ground Vegetation	Site Description
Grand Lake Road	Jack Pine	30	fire	rhododendron bracken fern	podzolic sandy loam, good drainage, flat
Tracadie North and South	Jack Pine	40	fire	sheep laurel bracken fern	podzolic sand, 1" humus, good drainage, flat

Appendix III. Five-year periodic growth and fertilization response for Dunbar Stream.

Stand Parameter	Untreated Stand			Response							
	initial	final	increment	AN112	AN168 P112	AN168 K112	P112 K112	AN168 P112 K112	K112	P112	URN168
dbh	#21.6	24.4	2.8								
BA	38.2	48.4	10.2	2.2	-1.3	-0.1	-1.9	-0.4	1.4	-1.4	-1.5
TV	321.4	425.0	103.5	24.9	-11.7	1.4	-20.5	1.7	14.1	-13.5	-15.2
MV	281.9	383.3	101.4	23.9	-11.6	1.0	-19.2	1.3	13.8	-13.4	-15.0

dbh (cm), BA (m^2/ha), TV and MV (m^3/ha)

Appendix IV. Five-year periodic growth and fertilization response, six-year response for Stairs Hill.

Location	Stand Parameter	Untreated Stand			Response					
		initial	final	increment	URN112	AN112	URN224	AN224	URN448	AN448
Crow Hill	dbh	#14.5	15.8	1.3						
	BA	20.7	24.4	3.7	0.0	-0.6	0.0	0.2	0.1	0.1
	TV	131.6	160.1	28.5	2.2	-0.3	0.5	0.5	0.7	0.2
	MV	89.3	118.8	29.5	2.3	-0.7	0.3	0.6	1.1	0.0
Stairs Hill	dbh	13.8	15.1	1.3						
	BA	16.6	19.9	3.3	-0.6	0.6	-0.1	0.0	0.2	0.4
	TV	98.8	121.2	22.4	-3.7	4.5	-1.0	0.9	1.8	3.0
	MV	60.6	84.2	23.6	-3.5	4.8	-1.3	0.7	1.8	3.3
Magaguadavic (S)+	dbh	15.6	16.0	0.4						
	BA	21.2	22.4	1.2	0.5	1.0	0.8	1.1	1.1	1.3
	TV	157.5	168.1	10.6	4.1	7.7	7.1	9.1	9.7	10.6
	MV	115.1	126.2	11.1	3.9	8.2	7.4	9.3	9.9	10.9
Magaguadavic (F)	dbh	15.7	16.3	0.6						
	BA	21.2	22.7	1.6	0.7	0.7	1.2	1.1	1.5	1.6
	TV	156.9	170.4	13.5	5.5	5.7	10.5	9.7	12.4	13.4
	MV	115.6	129.7	14.1	5.7	5.8	10.4	9.7	13.0	14.1

dbh (cm), BA (m^2/ha), TV and MV (m^3/ha)

+ indicates fertilizer applied in the spring (S) and in the fall (F)

Appendix V. Ten-year periodic growth and fertilization response.

Location	Stand Parameter	Untreated Stand			Response						
		Initial	Final	Increment	URN168	URN168 P56	URN224	URN224 P112	URN336	URN336 P112	AN224
Rogersville	dbh	#12.0	13.7	1.7							
	BA	24.0	31.3	7.3	2.1	1.7	1.3	2.1	3.0	2.4	-
	TV	153.4	206.4	53.0	16.5	13.8	10.6	17.2	23.8	19.2	-
	MV	117.0	171.4	54.4	16.6	13.7	10.8	17.0	23.8	19.0	-
Tracadie Range	dbh	13.2	14.9	1.7							
	BA	24.7	30.3	5.6	1.3	1.8	1.8	2.2	2.7	3.8	2.5
	TV	159.6	209.4	49.8	3.5	7.1	7.4	10.4	13.8	21.8	12.9
	MV	128.9	179.3	50.4	2.8	7.0	7.1	9.7	13.6	22.1	12.7
County Line	dbh	13.0	14.7	1.7							
	BA	22.7	28.9	6.2	0.1	0.5	0.9	1.5	1.2	0.6	0.9
	TV	149.6	195.8	46.2	1.2	5.0	7.2	12.3	9.5	5.9	7.1
	MV	119.2	166.4	47.2	0.7	4.6	7.0	12.3	9.6	5.3	7.1

dbh (cm), BA (m^2/ha), TV and MV (m^3/ha)

Appendix VI. Five-year periodic growth and fertilization response for Salmon Brook, six-year response for Grand Lake Road.

Location	Stand Parameter	Untreated Stand			Response											
		initial	final	increment	0-I	0-H	100-0	100-I	100-H	200-0	200-I	200-H	300-0	300-I	300-H	200-H (2)
Salmon Brook	dbh	#8.8	9.7	0.9												
	BA	25.1	30.8	5.7	0.3	-0.3	0.6	1.1	0.4	1.7	1.9	1.2	2.2	2.3	1.9	0.5
	TV	132.4	166.3	33.9	1.7	-0.2	2.6	6.4	3.0	10.0	11.5	8.7	12.3	13.6	13.0	4.1
	MV	55.7	93.1	37.4	3.0	-1.1	1.9	7.3	4.5	9.9	12.8	9.6	12.5	14.8	14.6	4.9
Grand Lake Road	dbh	8.1	9.5	1.4												
	BA	19.3	26.2	6.9	0.4	0.3	0.7	1.1	0.0	1.9	1.1	1.6	0.6	2.5	1.0	1.2
	TV	86.6	123.4	36.8	4.4	4.8	5.4	10.6	2.6	13.3	6.0	12.4	6.8	15.9	11.5	9.1
	MV	24.3	61.0	36.7	6.7	8.0	5.2	11.3	5.2	14.5	6.5	14.5	7.4	17.5	13.8	13.5

dbh (cm), BA (m^2/ha), TV and MV (m^3/ha)

Appendix VII. Five-year periodic growth and fertilization response.

Location	Stand Parameter	Untreated Stand			Response												
		initial	final	increment	0-I	0-H	100-0	100-I	100-H	200-0	200-I	200-H	200-I (2)	200-I (3)	200-H (2)	200-H (3)	200-H (4)
Tracadie North	dbh	#10.7	11.4	0.7													
	BA	27.8	31.8	4.0	-0.4	-0.1	0.1	0.5	0.2	0.9	1.2	0.5	1.1	0.7	0.3	0.1	0.1
	TV	170.9	200.9	30.0	-2.9	2.2	1.0	4.6	4.7	6.2	10.2	7.4	7.8	6.5	4.4	2.7	0.5
	MV	115.3	146.8	31.5	-3.3	0.6	0.5	4.1	3.0	6.5	9.5	5.8	8.2	5.9	3.4	1.5	-0.5
Tracadie South	dbh	10.2	10.9	0.7													
	BA	25.4	29.3	3.9	-0.1	-0.4	1.3	1.5	1.1	2.3	0.4	1.9	1.8	1.3	1.3	0.0	-0.3
	TV	136.0	161.0	25.0	-1.2	-1.6	8.5	11.3	8.6	13.8	21.7	15.3	12.7	9.4	10.4	1.1	-1.0
	MV	81.6	108.6	27.0	-1.3	-2.8	8.7	10.9	7.7	14.6	21.1	14.1	12.5	9.6	9.6	0.2	-2.1

dbh (cm), BA (m^2/ha), TV and MV (m^3/ha)

Appendix VIII. Statistical significance of fertilization effects on IV increments at individual locations.

Location	F[1]	Treatments in sequence of increasing mean IV increment[2]
Dunbar Stream	2.19	P112K112 URN168 K112 P112 AN168P112 CONT AN168K112 AN168P112K112 AN112
Crow Hill	0.26	AN112 CONT AN448 AN224 URN224 URN448 URN112
Stairs Hill	1.75	URN112 URN224 CONT URN448 AN224 AN112 AN448
Magaguadavic(S)	6.33**	CONT URN112 URN224 AN112 AN224 URN448 AN448
Magaguadavic(F)	6.44**	CONT URN112 AN112 AN224 URN224 URN448 AN448
Rogersville	8.22**	CONT URN224 URN168P56 URN168 URN224P112 URN336P112 URN336
County Line	3.48**	CONT URN168 URN168P56 URN336P112 AN224 URN224 URN336 URN224P112
Tracadie Range	3.79**	CONT URN168 URN168P56 URN224 URN224P112 AN224 URN336 URN336P112
Salmon Brook	18.26**	0-H 0-0 0-I 100-0 100-H 200-H(2) 100-I 200-H 200-0 200-I 300-0 300-H 300-I
Grand Lake Rd	4.83**	0-0 100-H 0-I 0-H 100-0 200-I 300-0 200-H(2) 100-I 300-H 200-H 200-0 300-I
Tracadie North	7.32**	0-I 0-0 200-H(4) 100-0 0-H 200-H(3) 200-H(2) 100-I 100-H 200-0 200-I(3) 200-H 200-I(2) 200-I
Tracadie South	24.85**	0-H 0-I 200-H(4) 0-0 200-H(3) 100-0 100-H 200-I(3) 200-H(2) 100-I 200-I(2) 200-0 200-H 200-I

[1] All F ratios were obtained by analysis of covariance.

[2] Treatments underscored by the same lines had means which did not differ significantly at P = 0.05. Sequences with no underlining did not include significant treatment effects.

** Significant at P = 0.01.